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Tophaceuos CPPD deposition disease of the temporomandibular joint: A preferential site?

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Abstract

Background: Calcium pyrophosphate dihydrate deposition disease is a common feature in joints and increases with age. The tophaceous variant is much less commonplace. The available literature is reviewed and a new case reported.

Methods: A thorough online search was performed using specific keywords. All relevant articles were acquired and all patient related data was analyzed.

Results: 58 patients including our own could be identified of suffering from TCPPD deposition in the TMJ area. The average age for TMJ TCPPD was 60.2 years, 63.8% were female. The most common symptom was pain, closely followed by swelling. Most depositions were localised intraarticularly, commonly extending to periarticular tissue. Multiple imaging techniques were used. Bony erosions intraarticularly were present in 74%, 12 patients demonstrated an eroded skull base and in 5 cases this resulted in penetration to the middle cranial fossa.

Conclusions: The TMJ is a preferential site for TCPPD deposition disease. It can lead to significant destruction of articular/periarticular tissue and has to be differentiated from malignancies in this area. CT and MRI as well as needle aspiration cytology are recommended, mild symptoms should be treated clinically but suspicion of destructive tendencies warrants surgical treatment.

Level of Evidence: III

Introduction

Calcium pyrophosphate dihydrate (CPPD) deposition disease is a metabolic disorder characterized by non-infectious joint inflammation with intra- or periarticular calcification ¹. In 1962 McCarty ² and his team were the first to describe the association of CPPD crystals in the synovial fluid of knees of patients with cartilage calcifications visible on standard radiographs, termed chondrocalcinosis³, and acute symptoms commonly associated with gout. Most population based research uses chondrocalcinosis as the basis for the presence of CPPD and this is strongly associated with an increase in age. Over the age of 60 6 to 15% of patients demonstrate radiological signs of chondrocalcinosis and over 80 years the prevalence increases to 30 to 40% ^{1, 4}. Despite increasing awareness the majority of manifestations are likely to be underdiagnosed ⁵. Ryan et al.⁶ proposed the term CPPD deposition disease since symptoms can vary widely from asymptomatic to acute or chronic manifestations ³. Acute synovitis associated with CPPD crystal deposits is termed pseudogout while pyrophosphate arthropathy characterises the long-term endpoint with structural joint alterations. CPPD deposition disease is most commonly found in intraarticular fibrocartilage of the knee, the triangular ligament of the wrist, symphysis pubis, shoulder and the temporomandibular joint (TMJ) ⁴. Periarticular structures are affected in up to 52% ⁷. Some patients develop remarkable pseudotumoral calcifications that may cause symptoms directly or indirectly by compression of periarticular structures such as the myelon ⁸. This presentation is termed tophaceous pseudogout (tophaceous CPPD deposition disease (TCPPD), tumorous pseudogout) and is most commonly reported in the

TMJ area ⁹. Pritzker ¹⁰ was the first to describe such a massive CPPD deposition in the surrounding soft tissue of a TMJ in 1976.

Case report

A 75 year old male patient first presented to the out-patients clinic of our department in 2005. His chief complaint was a single episode of open locking of his right jaw the previous day during chewing. The mandible repositioned spontaneously, but the patient subsequently felt that his bite was slightly open on the ipsilateral side and he reported localized TMJ pain and swelling. His past medical history was notable for arterial hypertension, prostate hyperplasia and malaria in 1994. Conventional radiographs showed no abnormalities. The patient was discharged with a tentative clinical diagnosis of a first episode of condylar displacement of the right TMJ. Upon follow-up visits, the patient reported that the occlusal disturbance quickly disappeared without recurrence. In 2009 the patient presented to our Orofacial Pain Unit complaining of persistent painful closed lock of the right TMJ of recent onset. The clinical examination demonstrated no preauricular swelling and only mild pain on compression of the right preauricular region. Magnetic resonance imaging (MRI) of the TMJ revealed a 27mm sized T2 hypointense mass originating from the right articular eminence with anterior intraarticular extension (*Fig 1a,b*). Computed tomography (CT) showed significant calcification of the lesion without adjacent bone destruction (*Fig 2a,b*). Differential diagnosis included osteochondroma, synovial sarcoma, synovial chondromatosis, pigmented

villonodular synovitis, chondrosarcoma, gout, CPPD deposition disease and amyloid deposition.

The patient was hospitalised for tumour resection. On admission the interincisal distance was 43mm, TMJ pain was experienced during palpation and during laterotrusion to both sides. All blood tests (electrolytes, kidney and liver parameters, cholesterol, iron, ferritin, thyroid stimulating hormone, hemoglobin, hematocrit, thrombocytes) were within normal limits. Surgical revision was performed by way of a preauricular/coronal incision with zygomatic osteotomy to gain access to the retromaxillary space ¹¹ (*Fig 3*). The tumourous tissue had an off-whitish hue and a granulated, pasty consistency. Intraoperative biopsies revealed no malignancy and therefore sparing resection was performed. The patient recovered without complications and could be discharged on the second postoperative day. Subsequent histologic examination confirmed the intraoperative suspicion of CPPD. Upon follow up the patient reported no TMJ pain or functional limitation and TMJ imaging by CT and MRI confirmed complete removal of the lesion.

Materials and Methods

The patient consented to have his records prepared for publication.

A PubMed search encompassing the English speaking literature was performed using Boolean combinations of the keywords: Chondrocalcinosis, pseudogout, TMJ, temporomandibular joint, infratemporal fossa, parotid, CPPD, calcium pyrophosphate dihydrate disease. The resulting abstracts were screened for relevance and the appropriate articles acquired and read. The pertinent datasets for each article were entered into a spreadsheet using each patient as a single entity. If specific signs or symptoms were reported but not others then those not mentioned were considered not to be present. If signs and symptoms were not discussed at all they were considered unavailable (n/a).

A second PubMed search not limited to the TMJ was performed searching for tophaceous pseudogout, CPPD deposition disease and crowned dens syndrome. All localisations were recorded.

Results

Four articles were dismissed since identical patients were described in secondary articles¹²⁻¹⁵. 54 articles reporting on CPPD in the TMJ with a total of 57 patients were included. The total number of cases add up to 58 when including our patient. An overview of all articles included can be found in *Table 1*^{9,10,16-63}.

The PubMed search for tophaceous CPPD without limitation to the TMJ added an additional 48 patients^{8,9,64-96}. 16 patients had deposits in the hand and cervical spine respectively, other locations included the foot, hip and acromioclavicular joint. If the crowned dens syndrome (CDS), crystalline deposits around the odontoid process of the axis, is used as a single search term 29 articles with 168 patients can be found^{65,97-124}.

For CPPD in the TMJ, the average age was 60.2 years (male 59.8, female 60.6 years). With only one article not reporting on gender, we found a predominance in females (63.8%). The left TMJ (33 cases) was more commonly affected than the right joint (20 cases). Two cases had bilateral TCPPD. Information on the affected side was lacking in three cases.

Symptoms:

The most common complaint on presentation was either spontaneous or chewing dependant pain mentioned by 40 patients. 31 patients presented with preauricular swelling. Pain as an isolated symptom was reported in 16 cases and in 11 cases, swelling was the only symptom. An additional 16 patients experienced both pain and swelling and in one case this was accompanied by

hearing loss. 8 patients in total experienced hearing loss, while TMJ clicking and tinnitus were symptoms in 2 patients respectively. Malocclusion and open lock were observed in one patient and in one case the tumourous deposits were an incidental finding on imaging.

Signs:

While pain on palpation was also very common on initial presentation (43 patients) swelling was recorded most often in 45 patients. 39 patients suffered from trismus, although interincisal distance (IID) was reported only in a minority of articles with an average of 22.8mm (range 10-35 mm). Malocclusion, crepitus, clicking and open lock were also occasionally reported.

Imaging:

Details of imaging procedures (conventional radiography, CT, MRI, scintigraphy) are listed in *Table 1*. Information on imaging technique was lacking in one case. CT was most commonly reported in 41 cases, closely followed by conventional 2-dimensional x-rays in 33 cases. Tomograms were rarely obtained after 1980s and MRI exams became increasingly common. Only five articles limited the scope of their imaging examinations to conventional x-rays and these patients were all seen before 1987. Patients usually had more than one set of imaging data and from the mid 1990s onwards most patients were evaluated by both CT and MRI scans. As in our case MR was followed by CT in 17 out of 23 MRI examinations.

TCPPD location:

Intraarticular CPPD deposits were found in 34 patients, of whom 19 patients had deposits in this location only. Of the 37 cases with periarticular manifestations, the location was circumferential in 14, anterior and medial in 12 respectively,

lateral in 6 and posterior in 5 cases. Various combinations of intra- and periarticular presentations existed.

TMJ destruction and other joint involvement:

TMJ destruction was present in 74.1% (43/58) of all affected joints. Details regarding joint morphology were missing for five patients. Erosion usually affected both the condyle and the fossa and was always adjacent to CPPD deposits. The skull base was eroded in twelve cases and in five cases this erosion resulted in penetration into the middle cranial fossa. Erosion was most commonly observed in intraarticular and medial localisations.

29% (17/58) reported symptoms in other joints. Besides the TMJ, CPPD was observed in the knee, wrist, pubic symphysis, shoulder and ankle in three patients, though none of them were tophaceous lesions. In the majority of cases, however, joint involvement was non-specific, namely without CPPD deposits. Few patients were diagnosed with arthritis of the spine (two cases) or knee (one case). Two patients suffered from generalized arthritis (rheumatoid arthritis and non-specific arthritis). Two patients had bilateral tophaceous CPPD depositions.

Differential diagnosis:

Neoplastic lesions of any kind were suspected in 22 patients with chondrosarcoma being the most commonly considered etiology. Among non-neoplastic diseases, synovial chondromatosis was deemed possible nine times. In 18 cases, no differential diagnosis (DD) was reported. *Table 2* summarizes the differential diagnoses that were reported.

Preoperative tissue sampling:

Preoperative sampling was performed on only 23/58 patients (*Table 1*). The most common procedure was needle aspiration cytology, two of them were CT guided. Conventional surgical biopsies were obtained in seven cases. One endoscopic and one transaural biopsy were also performed. In the majority of cases the result was CPPD but in three cases the samples revealed an incorrect diagnosis: one was inconclusive, one diagnosed a cartilaginous tumour and one a chondrosarcoma.

Treatment:

79.2% of the patients were treated surgically and 10.4% conservatively. 5.2% received no treatment and in 5.2% of all cases the treatment modality was not reported (*Table 1*).

Macroscopy/Histology:

The intraoperative specimen was usually described as being off-whitish, soft granular gritty tissue with some calcifications. All were eventually diagnosed as CPPD by histology.

Outcome:

Conservative or no treatment yielded good results in 8 of 9 cases, the outcome of one case was not specified. Surgical revision resulted in one case of facial nerve paralysis and two with persistent TMJ pain, albeit on a much lower level (*Table 1*).

Relevant associated illnesses:

Relevant associated illnesses included elevated PTH levels, hypercalcemia, hyperuricemia/gout, arthritis and non-specific joint pain, diabetes and hypothyroidism. Only a single patient reported direct trauma to the mandible. Details are listed in *Table 1*.

Discussion

TCPPD is an uncommon variant of CPPD deposition disease and according to our review it is most commonly reported in the TMJ. We found 58 patients with TCPPD in the TMJ whereas only 48 reports of patients with TCPPD in other joints could be found in the English speaking literature. Compared to the number of people suffering from chondrocalcinosis or CPPD, respectively, these cases are exceptional. Crowned dens syndrome (CDS) has recently been reported to be one of the more common forms of significant crystal, either CPPD or hydroxyl apatite, deposition diseases. However most cases of CDS do not represent tophaceous lesions but are rather small in size. Goto et al.¹⁰³ describe tuberculous lesions in only 2 of 40 patients on review. This may be a function of the location of the lesion and probable earlier presentation of patients with CDS to medical care than TCPPD in the TMJ.

Pain and swelling localized to the TMJ were the most commonly reported signs and symptoms. Interestingly pain and swelling were recorded more often upon examination than on interview. The slow growing nature, reflected by subclinical trismus in most patients could account for this. Disease accompanying hearing loss was mistakenly attributed to presbycusis and was commonly ignored for a significant amount of time. Occlusal discrepancies were only occasionally reported and the facial nerve remained unaffected in all patients.

The clinical differential diagnosis of swelling in and around the TMJ can be challenging, since only the lateral joint aspect is amenable to palpation. Few of

the TCPPD deposits were located lateral to the joint. This might explain diagnostic delays, particularly in cases with surprisingly large lesions as in our own case.

The workup in our clinic started with conventional radiography and illustrates its limitations. Four years prior to diagnosis, orthopantomography of our patient did not reveal calcifications large enough to indicate a growing mass in the glenoid fossa. Early examination by CT or cone beam CT (CBCT) might have resulted in earlier diagnosis, but CBCT was unavailable in our clinic at that time. CBCT can be very helpful as a first-line tool for radiographic analysis, since radiation doses are continuously decreasing with new product generations. CT and CBCT precisely depict lesion topography, size, degree of calcification and potential adjacent bone erosion. MRI is better at detecting lesions in intra- or extraarticular locations and their relationship to the articular disc, parotid gland, facial nerve and infratemporal fossa.

Preoperative biopsies were obtained in only 23 of 58 patients. Though they were not 100% reliable, they were helpful in excluding malignancies and thus in preventing overly aggressive, presumably curative resections. The most reliable results were obtained by needle aspiration cytology. No advantage is evident from open biopsies prior to resection.

For surgical treatment an extraoral (preauricular or coronal) incision was the preferred access. Removal of the lesion was accomplished either by lateral parotidectomy or through osteotomies allowing access to the infratemporal fossa. Only very few articles describe intraoperative histology, which might have

prevented some of the more aggressive resections. One patient was misdiagnosed as having a malignancy and was subsequently irradiated. The histology report was revised at a later date and aggressive treatment was halted.

75% of patients show some cartilage or bony destruction either on imaging or upon intraoperative inspection. Usually both, condyle and fossa, were equally affected. 12 patients had erosions of the skull base, usually emanating from CPPD deposits in the infratemporal region. This observation reveals the remarkable destructive potential of tophaceous variants of the disease.

15% of patients had no resective treatment, and in 5.2% no treatment was initiated at all (see *Table 1*). Patients treated conservatively did not develop clinically relevant problems. These were however patients with only minor swelling and minimal pain. Surgical treatment also had favorable results for most patients with the exception of one case who developed partial facial nerve paralysis. Overall the surgical removal of destructive lesions outweighs the risk of adverse surgical events.

14% of patients with tophaceous pseudogout of the TMJ suffered from a metabolic disease. Unfortunately most articles failed to report on a hematologic work-up. Only one report mentioned trauma to the TMJ prior to the development of a tophaceous swelling, and one patient had a neck trauma six years prior. There seems to be little basis for TCPPD of the TMJ being post-traumatic and there is no clear link to specific metabolic imbalances to be found in the literature.

In summary, compared to other joints, the TMJ is preferentially affected by TCPPD deposition disease. A thorough history and detailed clinical exam is to be supplemented by CT/CBCT and/or MRI. Particularly in patients younger than 60 years metabolic disorders need to be ruled out ⁴. Preoperative FNA is recommended for confirmation of the diagnosis. Conservative treatment with regular follow-up is suitable for patients with mild symptoms and non-destructive disease. Operative revision is advocated for intolerable symptoms and/or erosive disease. Recurrence of lesions is rarely observed.

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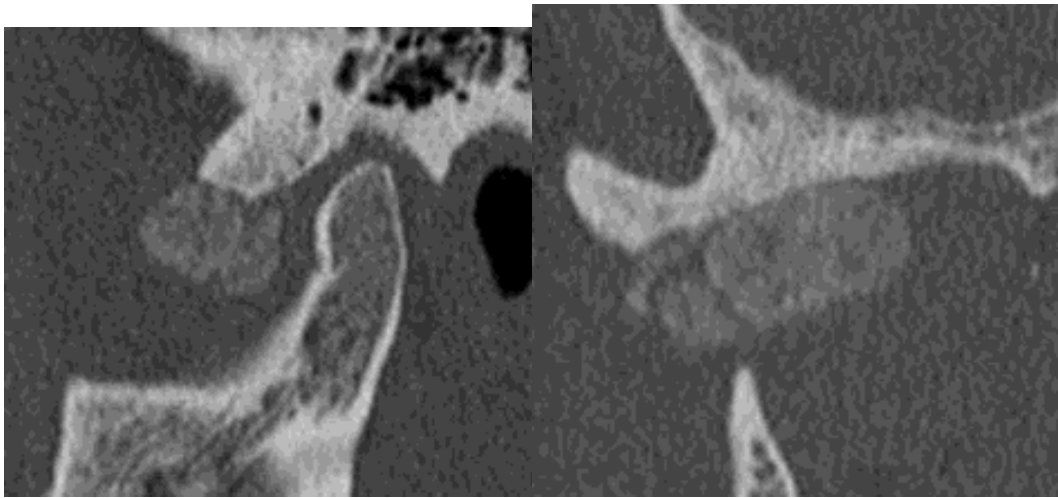
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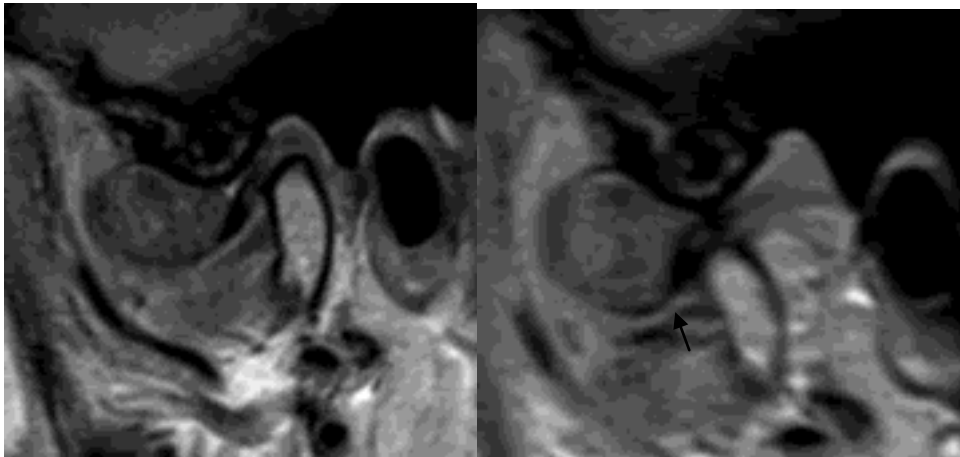
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Figure 1 a/b



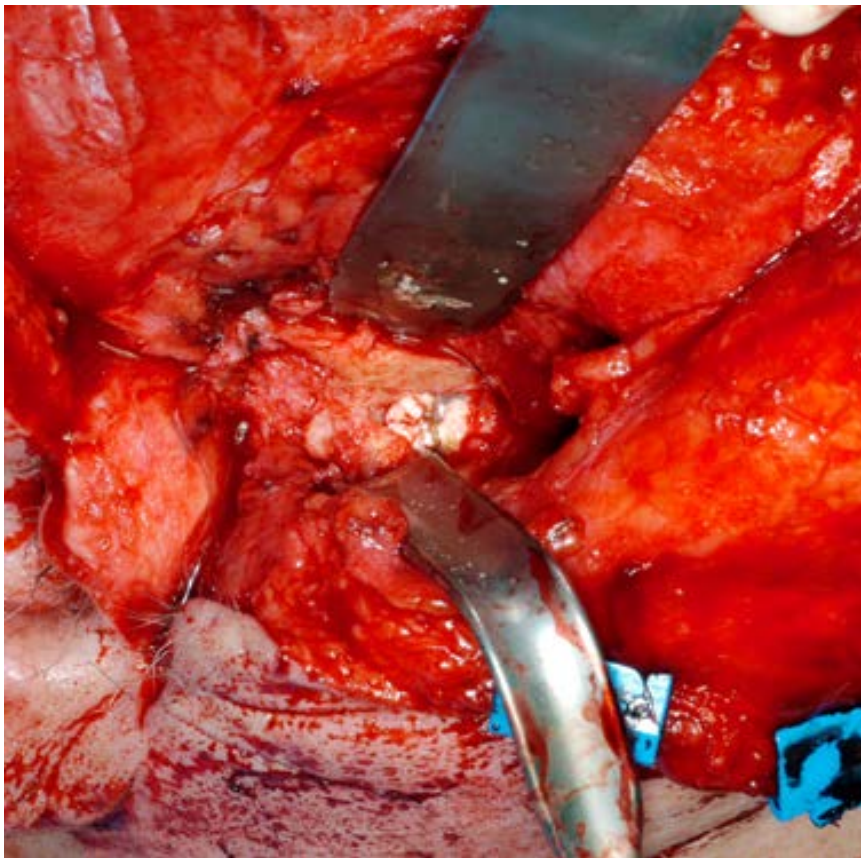
CT images in the sagittal oblique (a) and coronal plane (b) show an intrarticular noncorticated well marginated calcified lesion that abuts the articular surface of the glenoid fossa. There are no signs of osteoarthritis.

Figure 2 a/b



Sagittal oblique MR Image with closed (a) and open mouth (b) position depicts intraarticular well defined calcification in contact with the articular disc (→) and the articular eminence. The calcification displays limited mobility in the open mouth position.

Figure 3



Right infratemporal fossa with whitish, tumorous mass after coronal access, preauricular incision and zygomatic osteotomy

Tophaceous CPPD deposition disease of the temporomandibular joint: A preferential site?

Table 1

| Referen ce | publ - Dat e | c a s e | a g e | s e x | sid e | conventi onal x- rays | tom ogra m | C T | M R I | Sz in ti | n / a | preop biopsy | treatment | recu rren ce | outcome | relevant illnesses |
|-----------------|-----------------------|------------------|-------------|-------------|-------------------|-----------------------------|------------------|-------------|-------------|----------------|-------------|------------------------------|---|--------------------|---|---|
| Pritzker KP | 197 6 | | 5 5 | m | rig ht | yes | yes | | | ye s | | | Resection of upper third of ramus, partial extirpation of lesion, parotidectomy | | 6 months after OP development of subacromial bursitis | diabetes |
| de Vos RA | 198 1 | | 5 1 | f | left | yes | yes | | | | | | Tumour resection, discectomy | | good | generalised CPPD |
| Good AE | 198 2 | | 5 6 | m | left | yes | | | | | | yes (aspirate from wrist) | Indometacine | | good | bruxism |
| Zempen yi J | 198 5 | | 5 1 | f | left | | yes | y e s | | | | | superficial parotidectomy 1979. Total parotidectomy 1981 | yes | good after revision | hyperuricemia |
| Sailer HF | 198 6 | | 7 6 | f | left | yes | yes | y e s | | | | | Tumour resection | | good | none |
| Gross BD | 198 7 | | 5 9 | f | left | yes | | | | | | | Arthroplasty, discectomy, Teflon implant | | good | various arthritic joints |
| Hutton CW | 198 7 | 1 | 7 8 | f | rig ht | yes | | | | | | yes (aspirate) | none | | good | previous pseudogout of knee |
| Hutton CW | 198 7 | 2 | 7 6 | f | rig ht | yes | | | | | | yes (aspirate) | NSAIDS | | good | 10 year history of knee and finger pain |
| Hutton CW | 198 7 | 3 | 6 8 | f | rig ht | yes | | | | | | yes (aspirate) | none | | good | 8 month history of polymyalgia rheumatica |
| Kamatan i Y | 198 7 | | 5 7 | m | left | | yes | | | | | | Tumour resection, condylectomy | | good | trauma to the mandible 6 years previously, diabetes, angina pectoris |
| Mogi G | 198 7 | | 5 4 | f | rig ht | yes | | y e s | | | | | Tumour resection | | good | none |
| Lambert RG | 199 0 | | 4 1 | m | rig ht | | | y e s | | | | | Partial tumour resection (cranial portion left) | | continued limitation in TMJ mobility | none |
| Combells R | 199 2 | | 5 2 | n / a | left | yes | | y e s | | | | | Tumour resection, condylar osteoplasty | | good | none |
| Dijkgraaf LC | 199 2 | | 5 3 | f | left | yes | | y e s | y e s | | | | Tumour resection, high condylectomy | yes | good after revision | none |
| Magno WB | 199 2 | | 5 3 | f | left | | | y e s | | | | yes (open) | Wide resection with condylectomy and discectomy | | good | car accident with vertebral Fx years previously |
| De Bont LG | 199 3 | | 5 4 | f | left | yes | | y e s | | | | | Arthroplasty, discectomy, condylar shaving, synovectomy | yes | good after revision | none |
| Chuong R | 199 5 | | 6 5 | f | bila ter al | yes | | | y e s | | | | Tumour resection, discectomy | | good | hypothyroidism, hypertension |

Tophaceous CPPD deposition disease of the temporomandibular joint: A preferential site?

| | | | | | | | | | | | | | | | | |
|---------------------|------|---|----|---|-------|-----|--|-------------|-------------|-------------|--|-------------------------------|---|-----|---|--|
| Ishida T | 1995 | 1 | 47 | f | uni | yes | | | | | | | Tumour resection | | n/a | none |
| Ishida T | 1995 | 2 | 50 | f | uni | | | | | y e s | | | Tumour resection | yes | good after revision | none |
| Ishida T | 1995 | 3 | 55 | f | uni | | | | y e s | | | | Tumour resection | | n/a | none |
| Pynn BR | 1995 | | 58 | m | left | yes | | y e s | | | | | Tumour resection | | good | none |
| Allias-Montmaieur F | 1997 | 1 | 52 | m | left | | | y e s | | | | | Tumour resection | | good for TMJ, acute pseudogout attack of the left knee 6 months later | none |
| Allias-Montmaieur F | 1997 | 2 | 46 | f | left | | | y e s | | | | | Tumour resection | | good | none |
| Kurihara K | 1997 | | 85 | m | right | | | y e s | | | | | Tumour resection | | good | hyperuricemia, no gout-like symptoms |
| Onodera K | 1997 | | 48 | f | left | | | y e s | | | | | Tumour resection | | good | none |
| Vargas A | 1997 | | 66 | f | left | yes | | y e s | | | | | Tumour resection, condylectomy | | n/a | none |
| Jordan JA | 1998 | | 80 | m | right | | | y e s | y e s | y e s | | yes (open) | Wide en bloc tumour resection | | postoperative facial nerve paralysis | hypertension, hypercholesterolemia, gout |
| Strobl H | 1998 | | 51 | f | left | yes | | y e s | y e s | | | | Tumour resection | | n/a | none |
| Goudot P | 1999 | | 63 | f | left | yes | | y e s | y e s | | | | Tumour resection, temporal fascia flap | | good | none |
| Nakagawa Y | 1999 | | 76 | m | right | yes | | y e s | y e s | | | yes (aspirate) | NSAIDS | | good | none |
| Nakagawa Y | 1999 | 1 | 60 | f | right | yes | | y e s | y e s | | | | Tumour resection, condylectomy | | good | none |
| Nakagawa Y | 1999 | 2 | 45 | f | left | yes | | y e s | y e s | | | yes (CT guided needle biopsy) | none | | n/a | none |
| Aoyama S | 2000 | | 45 | f | left | | | y e s | y e s | | | yes (open) | Tumour resection, discectomy | | good | none |
| Li-Yu J | 2000 | | 72 | f | left | yes | | y e s | | | | yes (aspirate) | Craniotomy, Tumour resection. Histology: carcinoma --> radiotherapy. Histo re-evaluated: CPPD | | continued TMJ morbidity but less pain | hysterectomy, breast cancer (ductal carcinoma) |
| Lomoschitz F | 2000 | | 43 | f | right | yes | | y e s | | | | | n/a | | good | n/a |

Tophaceous CPPD deposition disease of the temporomandibular joint: A preferential site?

| | | | | | | | | | | | | | | | |
|-----------------|------|---|----|---|-----------|-----|--|-------------|-------------|-------------|------------------------------------|---|--|------|--|
| Mostafa pour SP | 2000 | | 65 | f | left | | | y e s | | | yes (endoscopically transnasal) | Craniotomy, extended tumour resection | | good | parathyroid adenoma, thyroid carcinoma, elevated PTH, hypercalcaemia, hypophosphatasia |
| Appel T | 2001 | | 67 | m | right | yes | | y e s | y e s | | yes (open) | Tumour resection, discectomy, condylectomy, silastic block | | good | none |
| Eriksson L | 2001 | | 72 | m | right | | | y e s | | | yes (aspirate) | Tumour resection | | good | none |
| Olin HB | 2001 | | 51 | f | left | yes | | y e s | | y e s | yes (aspirate) | Partial tumour resection | | good | n/a |
| Cottrell DA | 2002 | | 68 | f | right | yes | | y e s | | | | Partial tumour resection | | good | rheumatoid arthritis, hypothyroidism |
| Greaves S | 2002 | | 56 | m | bilateral | yes | | | | | yes (aspirate) | NSAIDS, Antibiotics, Diazepam | | good | hypertension, angina, parathyroid adenoma, nephrocalcinosis, knee joint replacement |
| Koitschev C | 2003 | | 66 | f | right | | | y e s | y e s | | yes (open) | None | | good | none |
| Osano H | 2003 | | 40 | m | left | yes | | y e s | y e s | | | Tumour resection | | good | none |
| Saliba I | 2003 | | 71 | f | left | | | y e s | y e s | | yes (transaurally under GI) | Tumour resection, middle ear resection | | good | none |
| Goldblatt F | 2004 | | 57 | m | right | yes | | y e s | | | yes (aspirate) | NSAIDS, Colchicine | | good | hypertension, hypercholesterolaemia, smoking, alcohol abuse |
| Marsot-Dupuch K | 2004 | 1 | 70 | f | right | | | y e s | y e s | | yes (CT guided needle biopsy) | n/a | | n/a | n/a |
| Marsot-Dupuch K | 2004 | 2 | 53 | m | left | | | y e s | y e s | | yes (open) | n/a | | n/a | n/a |
| Meul B | 2005 | | 54 | m | left | | | y e s | y e s | | | Tumour resection, condylectomy, discectomy, costochondral graft | | good | paraplegia following MVA 25 years previously, diabetes |
| Smolka W | 2005 | | 74 | f | left | yes | | y e s | y e s | | | Tumour resection | | good | meningitis 3 years previously |
| Cascone P | 2006 | | 64 | m | left | | | y e s | | | | Tumour resection | | good | hyperparathyroidism |
| Nicholas BD | 2007 | | 35 | m | left | | | y e s | | | yes (aspirate) | tumour resection, condylectomy, superficial parotidectomy | | n/a | hypercalcaemia, elevated parathyroid hormone level |
| Reynolds JL | 2007 | | 52 | f | left | | | | y e s | | | Tumour resection, condylectomy | | n/a | none |
| Ascani G | 2008 | | 72 | f | right | | | y e s | | | | Tumour resection, condylectomy, discectomy, costochondral graft | | good | none |

Tophaceuos CPPD deposition disease of the temporomandibular joint: A preferential site?

| | | | | | | | | | | | | | | | | |
|-----------|------|--|----|---|-------|-----|--|-------------|-------------|--|--|----------------|--|--|------|---|
| Mikami T | 2008 | | 59 | m | left | | | y e s | | | | yes (open) | Tumour resection | | good | arthritis knee |
| Covani U | 2009 | | 74 | f | right | yes | | y e s | | | | | Tumour resection including skull base revision | | good | none |
| Kalish LH | 2009 | | 71 | f | left | yes | | y e s | | | | | Wide en bloc tumour resection | | good | osteoarthritis, bilateral asymptomatic kidney cysts, gout, bilateral hearing loss |
| Kathju S | 2009 | | 78 | f | left | yes | | y e s | y e s | | | yes (aspirate) | Tumour resection, discectomy, condylectomy, TMJ prosthesis | | good | hypertension, DVT, bladder cancer, melanoma, TIA, osteoporosis |
| Zweifel D | 2011 | | 79 | m | right | yes | | y e s | y e s | | | | Tumour resection | | good | none |

Table 2

| Tumorous lesions | | Non-malignant lesions | |
|------------------------|----|------------------------------------|---|
| osteochondroma | 3 | unspecified | 1 |
| chondrosarcoma | 10 | degenerative illness | 1 |
| unspecified malignancy | 12 | osteoarthritis | 1 |
| chondroblastoma | 1 | synovial chondromatosis | 9 |
| chondroma | 3 | general crystal deposition disease | 1 |
| atypical meningioma | 1 | cholesteatoma | 1 |
| osteosarcoma | 1 | ADD without reduction | 2 |
| | | CPPD | 5 |
| | | arthritis | 3 |
| | | parotitis | 1 |
| | | ossifying fibroma | 2 |
| | | myositis ossificans | 1 |